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Iris L. Montgomery
Name
Iris L. Montgomery
Signature

SPECIFICATION

TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN THAT I, Dean A. Klein, a Citizen of the United States and a resident of Eagle, Ada County, ID, have invented certain new and useful improvements in a

BACKLIGHTING SYSTEM FOR AN LCD

of which the following is a specification.

BACKLIGHTING SYSTEM FOR AN LCD

Background of the Invention

1. Field of the Invention

The present invention relates generally to flat panel display systems. More particularly, the present invention relates to methods and apparatus for backlighting a liquid crystal display (LCD). Even more particularly, the present invention relates to backlighting a LCD on a laptop computer.

2. Description of the Prior Art

A conventional laptop computer, such as the laptop computer shown in Figure 1, utilizes a "fliptop" display to display computer data. The fliptop display is generally perpendicular to the body of the laptop computer when the laptop is in use, allowing the user to view the displayed computer data. When the laptop computer is not in use, the fliptop display is folded down into a closed position so that it is substantially parallel to the body of the computer.

The prior art fliptop display assemblies include a LCD housing. The LCD housing is typically hinged to the body of the laptop computer and generally operates as a protective cover for the LCD module.

Prior art fliptop displays also include an LCD module. The LCD module includes an LCD and a means for "backlighting" the LCD. Backlighting refers to generating light behind the LCD and uniformly projecting it through the LCD. Prior art backlighting techniques generally involve the use of a light source and a light pipe composed of light transmissive material located adjacent to the LCD. United

States Patent No. 5,050,946, which is incorporated herein by reference, discusses various light source and light pipe designs.

A cross sectional view of a conventional fliptop display 2 is shown in Figure 2. As shown in Figure. 2, the conventional fliptop display 2 includes an LCD housing 10 and an LCD module 15. The LCD housing 10 is composed of an opaque material (usually plastic) and protects the LCD module 15. The LCD module 15 is secured within the LCD housing 10 by various common securing means, such as screws, clips, or other frictionally engaging or interlocking means (not shown). Referring again to Figure 2, the LCD housing 10 has a rear portion 12 and top and bottom portions 11.

Referring again to Figure 2, the LCD module 15 includes an LCD 20, a light source 25, and a light pipe 30. The aperture 26 of the light source 25 is aligned adjacent to an end of the light pipe 30. As shown in Figure 2, the light pipe 30 is adjacent to the back surface 21 of the LCD 20. The LCD 20 is backlit when light generated by the light source 25 is conducted through the light source aperture 26 and coupled into an end of the light pipe 30. As shown in U.S. Patent No. 5,050,946, the coupled light may be uniformly diffused throughout the light pipe 30, and projected toward the back surface 21 of the LCD 20. Some conventional LCD modules utilize a light pipe 30 with a light-reflective coating applied to the back side 31 of the light pipe 30 (not shown). In this manner, light incident upon the back surface 31 of the light pipe 30 will be reflected back into the light pipe 30 for projection toward the LCD 20.

As shown in Figure 2, the length of the top and bottom portions 11 of the LCD housing 10, and hence the depth D of the flip top display 2, are roughly defined by the combined thickness of the rear portion 12 of the LCD housing 10 and the LCD module 15.

As shown in Figure 3, the depth D of the flip top display 2 is at least the sum of the thickness $d1$ of the rear portion 12 of the LCD housing 10, the diameter $d3$ of the light source 25, and some fractional portion of the thickness $d5$ of the LCD 20. In situations where the diameter $d3$ of the light source 25 is equal to the thickness $d4$ of the light pipe 30, the depth D may be the sum of the thicknesses $d1$, $d3$ (or $d4$), and $d5$.

For example, thickness $d1$ of the rear portion 12 of the LCD housing 10 may be 4 mm, the diameter $d3$ of the light source 25 may be 4 mm and the thicknesses $d4$ and $d5$ of the light pipe 30 and the LCD 20 may be 2 mm. As shown in Figure 3, these dimensions will result in the light source 25 extending 1 mm on either side of the light pipe 30. It can be seen that for this configuration of components, the depth D of the flip top display 2 will be at least 9 mm and the thickness $d2$ of the LCD module 15 will be 5 mm. In situations where the diameter $d3$ of the light source 25 is equal to the thickness $d4$ of the light pipe 30, the depth D of the flip top display 2 will be 8 mm and the thickness $d2$ of the LCD module 15 will be 4 mm.

In the laptop computer industry, it is always desirable to reduce the size and weight of the laptop computer and its component parts. It is also desirable to

1 minimize the number of parts. Thus, there exists a need for a thinner, less complex,
2 and lighter flitop display.

3 4 Summary of the Invention

5 One embodiment of the present invention is a computer display. The
6 computer display includes a LCD housing, a light source coupled to the LCD
7 housing, and a LCD coupled to the LCD housing. In this embodiment, the LCD
8 housing conducts light from the light source to the LCD.

9 Another embodiment of the invention is a method for conducting light. The
10 method includes generating light and conducting the generated light through a LCD
11 housing.

12 13 14 Brief Description of the Drawings

15 Figure 1 illustrates a perspective view of a laptop computer.

16 Figure 2 is a cross sectional view of a prior art flitop display for a laptop
17 computer.

18 Figure 3 is a close up view of the lower portion of Figure 2.

19 Figure 4 is a cross sectional view of a novel flitop display of a laptop
20 computer.

21 Figure 5 is a close up view of the lower portion of Figure 4.

1 Figure 6 is a close up view of an alternative embodiment of the lower portion
2 of Figure 4.

3 Figure 7 is a cross sectional view of an alternative embodiment of the present
4 invention.

5 6 Detailed Description of the Invention

7 Figure 4 illustrates a cross sectional view of a novel fliptop display 5. The
8 fliptop display 5 includes a planar LCD module 70 and a generally planar LCD
9 housing 50. The LCD module 70, which includes a planar LCD 71, is secured in the
10 LCD housing 50 by various common securing means, such as screws, clips, or other
11 frictionally engaging or interlocking means (not shown).

12 The LCD housing 50 is composed of a translucent material that functions as a
13 light pipe. For example, the LCD housing 50 may be formed from an ABS plastic
14 such as Lexan™ from General Electric. The LCD housing 50 may include a planar
15 rear portion 54 and top and bottom portions 55. As shown in Figure 4, a light source
16 60 may be partially embedded in or enclosed in the LCD housing 50. The light
17 source 60 may be secured in the LCD housing 50 by friction fit or by various
18 common securing means, such as screws, clips, or other frictionally engaging or
19 interlocking means (not shown). The LCD housing 50 may also have a
20 light-reflective coating 53 applied to its outer surface 58. The light-reflective coating
21 53, may be composed of aluminum or a variety of metallic or other reflective
22 substances. The light-reflective coating 53 reflects light incident upon it back into

1 the LCD housing 50 for projection to the LCD module 70. The reflective coating 53,
2 when made of materials such as electroless chrome followed by 40 to 50 (inches) of
3 copper, then nickel plating of 10 (inches) may also operate to minimize EMI
4 emissions from the flitop display 5. Alternatively, a nickel-copper-nickel plating
5 may be utilized. Because the reflective coating 53 forms the outer surface 58 of the
6 housing 50, it may be desirable to cover it or paint it with a protective layer 56
7 composed of a material such as soft touch polyethylene paint, that resists scratching
8 and preserves its desired optical qualities.

9 During operation of the flitop display 5, the light source 60 generates light.
10 This light is conducted through the LCD housing 50. The conducted light is then
11 projected into the back surface 72 of the LCD module 70.

12 Figure 5 shows a close-up view of the lower portion of Figure 4. In Figure 5,
13 the rear portion 54 of the LCD housing 50 has a thickness d6. The fractional portion
14 of the LCD housing 50 between its outer surface 58 and the light source 60 has a
15 thickness d7. (The light-reflective coat 53 and its protective layer 56 add a negligible
16 thickness). The light source 60 depicted in Figure 5 is a cold cathode fluorescent
17 lamp that has a diameter d3. For maximum light coupling, the cold cathode
18 fluorescent lamp 60 may be embedded in the LCD housing 50 so that the aperture 61
19 of the cold cathode fluorescent lamp 60 is completely adjacent to the LCD housing
20 50. The LCD module 70, which has a thickness d8, may be adjacent to the inner
21 surface 52 of the LCD housing 50. Thus, it can be seen from Figure 5, that the depth
22 D of the flitop display 5, closely approximates the sum of the thickness d7 of the

fractional portion of the LCD housing 50 between its outer surface 58 and the light source 60, the diameter d3 of the light source, and some fraction of the thickness d8 of the LCD module 70. It can also be seen that the depth D of the flip-top display 5 closely approximates the sum of the thickness d6 of the rear portion 54 of the LCD housing 50 and the thickness d8 of the LCD 71.

For example, using the dimensions previously discussed for these components, the thickness d_8 of the LCD 71 is 2 mm and the thickness d_6 of the LCD housing 50 is 4 mm. To provide maximum light coupling, the light source 60 with a 2 mm aperture 61 will be embedded in the LCD housing 50 so that 1 mm of diameter protrudes from the assembly. Accordingly, the thickness d_7 will be 1 mm, and the fraction of the thickness d_8 contributing to the depth D of the flip-top display 5 will be 1 mm. Thus, it can be seen that the depth D of the flip-top display 5 is now 6 mm. This depth D is 25% less than the depth of conventional flip-top displays.

Another embodiment of the present invention is shown in Figure 6. This embodiment, includes an omnidirectional light source 62. A reflector 63 is used to direct incident light generated by the omnidirectional light source 62 back into the LCD housing 50. As shown by the path traveled by light ray A, the light-reflective coating 53 will internally reflect light conducted into the bottom portion 55 of the LCD housing 50 until the light is eventually directed toward the rear surface 72 of the LCD module 70. Since all internal reflections will inherently have a lossy effect on the incident light, the junction of the rear portion 54 and the bottom portion 55 of the LCD housing 50 may be geometrically shaped so that light is reflected into the

rear portion 54 with a minimum amount of internal reflections. In this embodiment, the light source 62 need not be enclosed in the LCD housing 50 to the extent of the cold cathode fluorescent lamp 60 of Figure 5. In situations where a greater thickness d7 is required to protect the light source 62, the light source 62 may be enclosed in the LCD housing 50 at a variety of depths.

Still another embodiment of the present invention is shown in Figure 7. In this embodiment, the light source 62 and the reflector 63 may be located in the middle of the rear portion 54 of the LCD housing 50. The light source 62 may be partially enclosed in the LCD housing 50. The protrusion of the light source 62 (and the reflector 63) from the LCD housing 50 creates a gap 66 between the rear surface 72 of the LCD module 70 and the inner surface 52 of the LCD housing 50. This results in a larger gap 66 than required solely to accommodate the protrusion of the light source 62 from the LCD housing 50.

The gap 66 may be purposely designed into the flitop display 5 as a design tradeoff between depth D and lighting efficiency. While the depth D of the flitop display 5 will be increased, lighting efficiency may be improved. The addition of the gap 66 will provide the light with a greater depth d in which to diffuse before being incident upon the rear surface 72 of the LCD 71. This may provide better illumination of the LCD 71 toward the top and bottom portions 55 of the LCD housing 50.

Yet another embodiment is shown in Figure 8. In this embodiment, the thickness **d6** of the rear portion **54** of the LCD housing **50** in Figure 7 may be

increased in order to strengthen the LCD housing 50. For example, using the typical dimensions previously discussed for the various flip-top display components, the thickness d_6 may be increased up to 2 mm before the flip-top display 5 has the same depth D as in the prior art. As shown in Figure 8, the depth d of the gap 66 is correspondingly reduced.

In yet another embodiment, the LCD housing 50 can be designed to display a variety of ornamental effects. In this embodiment, areas of the light-reflective coating 53 can be masked or removed by scoring or by etching so that light incident upon these areas is no longer reflected back into the LCD housing 50, but instead is conducted out of the LCD housing 50. The protective layer 56 would also typically be similarly scored or etched in order to allow the light to leave the LCD housing 50. In this manner, text, company logos, trademarks, or other designs may be illuminated.

With respect to the embodiments described herein, it can be seen that the present invention's incorporation of the light pipe function into the LCD housing provides the laptop computer designer with greater design flexibility. The potential reduction in depth **D** of the fliptop display provides the laptop computer designer with a variety of configurations for the light source, LCD, and LCD housing assembly. The laptop computer designer may configure these components in a variety of ways resulting in a fliptop display depth **D** that is less than or equal to the width of the prior art fliptop display assembly. Additionally, the size and/or weight of the LCD module may substantially reduced. While this design flexibility has been

1 demonstrated in the description of the preferred embodiments, it is clear that many
2 other modifications, changes, variations, and substitutions are within the scope of
3 this invention.

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